

HABITATS OF COLEOPTERA¹

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An attempt is made below to distinguish the principal coleopterous habitats in terms of some of the immediate factors that determine the local distribution of a beetle fauna. The relationships involved are fundamental to but by no means identical with the further problem of ecological succession. The different stages in the ecological successions contain the species they do because of the conditions involved.

The fetish of a uniform terminology has not prevented the adoption of old terms, when such are at hand. Terms ending in "phagous" (as coprophagous, phytophagous, etc.) have been rejected as unavailable because they involve food relationships. Not all species inhabiting dung and plants feed upon the substratum, but some may be predaceous. The suffix "bious" (Greek βιόω, I live) implies only so much as is usually observed, the presence of the species in the habitat.

List of Habitats

- A. Associated with the physical environment.
 - 1. Geobious or ground habitat.
 - 2. Aquatic habitat.
 - 3. Cavernicolous or cave habitat.
- B. Associated with living organisms.
 - 4. Phytobious habitat, associated with green plants.
 - 5. Mycetobious habitat, associated with fungi.
 - 6. Termitophilous and myrmecophilous habitats.
 - 7. Parasitic habitat.
 - 8. Edificarian habitat, associated with the habitation of man.

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C. Associated with disintegrating organic remains.

9. Saprobious habitat, associated with dead or decaying vegetable matter.
10. Carpobious habitat, associated with fermenting fruit, sap, etc.
11. Xylobious habitat, associated with dead and decaying trees and wood.
12. Coprobious or dung habitat.
13. Necrobious or carrion habitat.

With the exception of the cavernicolous and edificarian, these habitats cut across rather than parallel ecological communities, and constitute consocieties and strata of several associations (Shelford, 1913, p. 37). On the other hand both cavernicolous and edificarian habitats contain species that might with equal propriety be otherwise classified: as geobious, coprobious, etc., in the case of the cavernicolous species; as saprobious, necrobious, etc., in the case of edificarian species. The termitophilous and myrmecophilous species among those living in habitats associated with living organisms, and practically all those living in habitats associated with disintegrating organic remains, together with the strictly geobious species, belong to the several consocieties or minor communities of the ground strata, and may occur in any of the associations except the aquatic. Exceptions to this are (1) guests of arboreal ants and termites, (2) mycetobious and xylobious species on or in trees that are still standing, and (3) possibly species of various relationships in the habitations of arboreal mammals or birds.

Species occur in a habitat for one of several reasons. (1) In the case of habitats associated with living or dead organic matter, the species may be feeding directly on the organic substratum. (2) The species may feed on other animals, or, as in the ambrosia beetles, on fungus living on the substratum. (3) The species may seek the situation for purposes of temporary shelter, (4) pupation, (5) copulation, or (6) oviposition. (7) The occurrence may be purely adventitious. Of especial importance among those species associated with living organisms is the phenomenon of specificity or the limited occurrence of the species

of parasite, used in the broad sense, on one or a few species of host.

1. Geobious habitat. Depending apparently on the amount of moisture and the nature of the substratum, at least five divisions of this habitat may be indicated. The conditions described were noted particularly on Beaver Island, Michigan, in the course of a coleopterological survey made for the Department of Conservation of the State of Michigan in 1922.

(1) The littoral habitat involves the strip of wet sand or mud along the strand line of lakes and ponds. It merges with the subaquatic littoral habitat on the one hand and the adjacent geobious habitat on the other. (*Stenus stygicus* Say, etc., *Bembidion*, especially the subgenus *Notaphus*, as *patruele* Dej., *cordatum* (Lec.), *versicolor* (Lec.), *variegatum* Say, etc., *Heterocerus*, *Omophron*, *Patrobus*, *Dyschirius*, *Georyssus*.)

(2) The beach habitat involves forms flying on the beach (*Cicindela repanda* Dej., *Bembidion carinula* Ch.) and forms under cover on the damp sand (*Bembidion transversale* Dej., *Agonum errans subcordatum* Lec., *Chlaenius brevilabris* Lec., *C. solitarius* Say, etc.).

(3) On dry sand of pine barrens under cover (*Harpalus erraticus* Say, *Celia musculus* (Say), *Cymindis pilosa* (Newm.)).

(4) On dry hard ground, under cover, such as occurs in the vicinity of cultivated fields, pastures, grassland, and high open woods (*Harpalus pennsylvanicus* DeG., *H. caliginosus* (Fab.), *Poecilus lucublandus* Say, *Calosoma calidum* Fab., etc.).

(5) On damp ground or humus, under cover, in low woods, margins of bogs, etc. (*Euferonia coracina* (Newm.), *Sphaeroderus lecontei* Dej., etc.).

2. Aquatic habitat. Aquatic Coleoptera do not represent a very extensive occupation of aquatic habitats, due to the fact (1) that the larvae on the whole must come to the surface for air (gyrinid and dryopid larvae possess gills, and very small larvæ may be able to effect an exchange of gases with the surrounding water directly through the body wall), (2) most forms must come to shore to pupate, (3) the adults are air breathers. The following habitats may be distinguished.

(1) The subaquatic littoral habitat, just below the water line, is inhabited by such species as *Laccobius agilis* Rand. It merges with the littoral habitat.

(2) The pond habitat contains the majority of aquatic Coleoptera. The surface and margins are readily accessible from all portions of the habitat. Such situations are ponds, pools, bogs (adults at least can withstand a considerable variation in hydrogen ion concentration), vegetation grown margins of small lakes, protected coves of larger lakes, and still coves and pools of streams and rivers.

(3) Rapids and running water habitats contain species of Dryopidæ and Elmidæ on the under side of stones and a few Dytiscidæ (Shelford, 1913, p. 102) that bury themselves in the sand of the bottom. Elmids have been found on the under side of stones on wave-swept beaches, where conditions are similar to those in rapids (ibid, p. 78).

(4) Surface habitat (Gyrinidæ), which may be divided into standing and slowly running water, with species peculiar to each.

(5) Submerged vegetation. This situation is practically uninhabited by Coleoptera, due to the difficulty the animals would have in coming to the surface. At Third Sister Lake, near Ann Arbor, Michigan, I found *Dineutus* larvae and adults of *Bidesus flavicollis* Lec. in such a situation.

3. The cavernicolous habitat is typically represented by blind silphids and carabids, but species with eyes belonging to numerous groups are likewise known.

4. Phytobious habitat. The great host of species associated with green plants may be subdivided into several groups. Many of the species, especially those feeding on the substratum, are specific in distribution.

(1) Phyllobious species, or species associated with foliage. They may be either phyllophagous (Chrysomelidæ, etc.) or predaceous (Coccinellidæ, etc.). Leaf mining species constitute a distinct division of this group.

(2) Antheobious or flower inhabiting species (adults of Mordellidæ, Cerambycidæ, etc.).

(3) Spermobious or seed inhabiting species (Mylabridæ).

(4) Histobious or tissue inhabiting species (curculionid larvae).

(5) Dendrobious or tree-trunk inhabiting species (Cerambycidae, Buprestidae, Ipidae and their guests, etc.). Ipidids may either feed directly on the substratum of the wood or on a fungous growth that lines their burrows. The ipidid guests are mostly predaceous. This habitat merges with the xylobious or decaying wood habitat. Blackman (1924) divides the habitats of the tree into (1) lower trunk, (2) upper trunk, above the first branches, and limbs over two and one-half inches in diameter, and (3) smaller branches and twigs.

5. Mycetobious habitat (Staphylinidae, Erotylidae, Mycetophagidae, etc., inhabiting fungi). The close relationship between fungous tissue and disintegrating organic matter is exhibited by the occurrence of the following forms in fungus (Weiss and West, 1920): *Cercyon*, *Necrophorus*, *Staphylinus*, *Philonthus*, *Hister interruptus* Beauv., etc., *Nitidula*, *Gleichrochilus*, *Onthophagus*, and *Geotrupes*.

6. Termitophilous and myrmecophilous species (Histeridae, Paussidae, Staphylinidae, Pselaphidae, Scydmaenidae, etc.). The species are often specific in distribution, and their exact food relationships are diverse, some undoubtedly serving as scavengers, others as predators, often upon the ants and their larvae, and others as true symphiles.

7. Parasitic species.

(1) Ectoparasites (*Platypyllus castoris* on beaver, *Leptinus testaceus* on shrews, and *Leptinillus validus* on beaver (Kellogg, 1914); three staphylinids on South American species of opossum, mouse, and guinea pig (Notman, 1923).

(2) Endoparasites (rhipophorid larvae in wasps and cockroaches).

8. Edificarian habitat (*Anthrenus scrophulariae* L. and the numerous grain and meal inhabitants). Strictly speaking, these species are living upon either dead vegetable or animal matter, and could be so classified, although the individuals are not always encountered directly associated with the organic substratum.

The species of all the remaining habitat groups may either feed directly on the substratum or be predaceous on other animals.

9. Saprobious habitat (Staphylinidæ and other inhabitants of masses of decaying leaves and grass, etc.).

10. Carpobious habitat (Nitidulidæ, Staphylinidæ, *Euphoria inda* (L.) and other species attracted by fermenting fruit, sap, etc.).

11. Xylobious habitat (Cerambycidæ, Buprestidæ, Passalidæ, mordellid larvae, etc.). This habitat merges with the dendrobious habitat, and consists of the dead and disintegrating tree as opposed to the living or dying tree.

12. Coprobious habitat (Staphylinidæ, Sphaeridiinæ, Histeridæ, Scarabaeidæ).

13. Necrobious habitat.

(1) Fresh carrion (Silphidæ, Staphylinidæ, Histeridæ, Nitidulidæ, etc.).

(2) Dry carrion (*Dermestes*, *Trox*, etc.).

(3) Bones (*Necrobia*, *Nitidula*).

Beetles are almost uniformly alate creatures, and dispersal takes place on the wing. The occurrence of individuals (1) in beach drift, (2) at light at night, and (3) on the wing is a result of this, and species belonging to any habitat may be so taken.

The wide range of the Staphylinidæ is noteworthy. Species of this family occur in all the habitats cited except the aquatic, edificarian, leaf-mining, spermobious, histobious, endoparasitic, dry carrion, and bone.

Habitats not occupied by Coleoptera. The surface of the ocean, inhabited by *Halobates* (Hemiptera), and the deeper waters of lakes, rivers, and to a slight extent, of the ocean, inhabited by dipterous and other gill-breathing insect larvae, are practically the only insect habitats uninhabited by Coleoptera. If other than insect habitats be taken into consideration, marine situations in general are uninhabited by them. Among terrestrial habitats, the rôle that beetles play as parasites is a very minor one, compared with groups like the Hymenoptera and the parasitic worms.

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THE INSECTS OF THE PANCHATANTRA

It is of interest to note that among the animal actors in the stories of the "Panchatantra," supposedly collocated in Kashmir about 200 B. C., insects play a small part. The stories have been translated recently, from the Sanskrit, by Arthur W. Ryder and published by the University of Chicago Press.

In the story entitled Leap and Creep, this and the others being Mr. Ryder's titles, Creep is a female louse living happily in the bed of a king, and Leap a flea who inveigles the louse into allowing him to sample the king's blood, the plan being for the flea to obtain his meal from the king's feet, when he was asleep or temulent. Instead of doing this, the blundering flea bit the king on the back which resulted in the sudden awakening of the king, a special search of the bed, the discovery of the louse and her family and their destruction.

In the Duel Between the Elephant and Sparrow the gnat assists by buzzing in the ear of the elephant thereby causing him to close his eyes in pleasure after which they were pecked out by a woodpecker. The frog croaking near the edge of a pit entices the elephant to the supposed water where he plunges to his destruction.

In the tale about the Unteachable Monkey a firefly is covered with dry grass and leaves and enjoyed as if it were a real fire, and in The Snake and the Ants a snake in spite of his strength and success in killing large numbers of ants is finally overcome by the exhaustless army. As in other fables, morals are pointed out; in fact the Panchatantra as a whole deals with "the wise conduct of life."—H. B. WEISS.